PIVOT MECHANISM FOR REEL MOWER CUTTING UNITS

BACKGROUND OF THE INVENTION

This invention relates to reel type mowers and the connection mechanisms which couple them to powered vehicles.

Conventional reel type cutting units are used to mow golf course greens and other areas where relatively precise and accurate mowing is desirable Reel type mowers typically include front and rear rollers which support the cutting units above the ground The height at which the cutting reel is fixed above the rollers determines the height of cut. An arm and yoke typically extend between the cutting unit and the vehicle for dragging the cutting unit along the surface of the ground.

A pivot mechanism is typically provided as a coupling between the yoke and arm for allowing the yoke and cutting unit thereattached to pivot and shift with respect to the arm and vehicle. These conventional pivot mechanisms often include a horizontally and longitudinally extending pivot shaft for allowing the yoke and cutting unit to pivot about a horizontal axis, thereby allowing the cutting unit to evenly engage and roll across the surface of the ground as the cutting unit encounters side slopes. Conventional pivot mechanisms also typically include a vertically extending steering shaft about which the yoke pivots from side to side for swinging the cutting units laterally as the vehicle executes a turn. The swinging of the cutting units during a vehicle turn generally allows the cutting units to follow or steer behind the pivot mechanism, thereby allowing the rollers to roll properly across the ground instead of dragging or skidding sideways. Scuffing or other damage to the ground is thereby reduced by the cutting unit's ability to steer or be pulled behind the yoke's connection to the arm.

Although conventional pivot mechanisms help reduce scuffing, the reel mower units can still scuff the ground undesirably in areas such as golf course greens where turf is highly manicured. During execution of a turn during mowing operations the inside lateral edge portion of the cutting unit can skid laterally and tends to dip down or dig into the turf, thereby often causing excessive turf damage.

Therefore, it would be desirable to provide a mechanism for coupling a reel mower to a vehicle and which reduces or eliminates turf damage occurring during execution of a turn during mowing operations

SUMMARY OF THE INVENTION

The preferred embodiment of the present invention provides a pivot mechanism couplable between a yoke and a push arm of a powered vehicle. An upright pivot mechanism is provided which allows the yoke and cutting unit thereattached to swing or pivot from side to side about a generally upright axis to properly steer behind the pivot mechanism when the vehicle makes a turn. The upright axis of the steering pivot mechanism is spaced a substantial distance forwardly from the rollers which support the cutting unit during mowing operations. The effective lever arm between the rollers and the upright pivot axis is relatively large, thereby reducing the amount of force required to pivot the cutting unit during a turn, which correspondingly reduces the lateral resistance forces encountered at the rollers during turns. Scuffing or other turf damage is thereby decreased. An inclined pivot mechanism is also provided, and includes an inclined axis which extends downwardly and rearwardly proximate the cutting unit's rollers for decreasing the effective lever arm between the inclined pivot axis and the lateral ground forces applied to the cutting unit at the rollers. The smaller lever arm acts to reduce the moment which causes the lateral edges of the cutting unit to dip or dig down into the turf during execution of a turn during mowing operations.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation view of a powered vehicle having the preferred embodiment of the present invention coupled to the front portion thereof.

FIG. 2 is a perspective view of the preferred embodiment of the present invention coupled between the front of the powered vehicle shown in FIG. 1 and a reel mower cutting unit. The direction of forward travel is to the right, and the pivot mechanism in the lower left of FIG. 2 is shown exploded.

FIG. 3 is a side elevation view of the push arm, pivot mechanism, yoke and cutting unit shown on the left in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIGS. 1 and 2, there is shown the preferred embodiment of the present invention as coupled to the front portion of a powered vehicle 10 for mounting a plurality of reel mower cutting units 12 thereto. Respective push arms 14 extend generally forwardly from the front portion of the vehicle 10 to be operatively coupled with the cutting units 12. The rear end portions 16 of the push arms 14 are pivotally coupled with the vehicle 10. A yoke 18 extends rearwardly from the front end portion 20 of each push arm 14. A cutting unit 12 is pivotally coupled to the rear portion 16 of each yoke 18. A pivotal coupling mechanism 22 described in greater detail below serves as a coupling between the yoke 18 and the push arm 14.

As best seen in FIGS. 2 and 3, the pivotal coupling mechanism 22 according to the preferred embodiment of the present invention provides an upright steering pivot means 24. A bracket 26 fixed to the front end portion 20 of the push arm 14 provides a pair of openings 28 within which an upright steering shaft 30 is received. A pin 32 secures the steering shaft 30 in place within the openings 28. A wire-like member 34 is coupled to the bracket 26 for generally rigidifying and strengthening the bracket 26. A pivot member 36 is provided which includes a generally vertically extending opening 38 which receives the upright steering shaft 30. The pivot member 36 pivots about the generally vertical axis of the upright steering shaft 30. The pivot member 36 and the upright shaft 30 act as an upright steering pivot means 24 for allowing the cutting unit 12 to follow or steer behind the front portion 20 of the push arm 14 during execution of a vehicle turn.

An inclined pivot means or inclined pivot mechanism 40 is also provided by the pivotal coupling mechanism 22. An inclined shaft 42 is received by the pivot member 36 and is held in place by a pin means 44. The yoke 18 defines an inclined central opening 46 which pivotally receives the inclined shaft 42. A pin 48 and washers 50 secure the inclined shaft 46 within the central opening

46. The yoke 18 includes a rear portion 52 which is longitudinally spaced from the front portion 54 of the yoke 18 a substantial distance. The rear portion 52 of the yoke 18 is pivotally coupled with the reel mower cutting unit 12. The inclined shaft 42 and central opening 46 in the yoke 18 provide an inclined pivot means 40 which allows the cutting unit 12 to tilt to either side such that the cutting unit's rollers 56 remain properly engaged against the ground when side slopes are encountered.

A leveling mechanism 70 as best seen on the right in FIG. 2 extends between the central rear portion of each cutting unit 12 and a respective push arm 14. Push arm rollers 72 shift upwardly with respective push arms 14 when the cutting units 12 are raised for transport. As the cutting units 12 are raised, the push arm rollers 72 engage bail members 74 which are coupled with the central rear portion of respective cutting units 12. The engagement of the push arm rollers 72 against the underside of the bail members 74 acts to lift the rear portions of the cutting units 12 in generally level fashion with the front portions of the cutting units 12. Removable grass catching baskets can be coupled to the front portion of the cutting units for collecting grass clippings, but are not shown in the Figures for the sake of clarity.

Next, the operation of the present invention will be discussed. Reel mower cutting units turn or follow their pivotal connection with a vehicle during a turn when a moment of particular magnitude is imparted to the cutting unit. A moment is the tendency of an object to swing about an axis when a force is applied to the object at a distance from the axis. The distance at which a force is applied to swing or pivot an object is referred to as a moment arm or lever arm. The longitudinal length of the yoke 18 of the preferred embodiment of the present invention acts as a moment arm or lever arm through which a force is applied to turn or steer the cutting unit 12 during a vehicle turn. During such a vehicle turn, the force is applied to the front portion of the yoke, which causes the yoke and cutting unit to pivot. Since the yoke 18 extends a relatively large distance longitudinally, the effective lever arm or moment arm established for steering or swinging the cutting unit 12 is relatively large. Therefore, the amount of force applied to the front portion 54 of the yoke 18 which is required to create a moment of sufficient magnitude to steer or swing the cutting unit 12 laterally is relatively small. As the lateral turning force is applied to the front portion 54 of the yoke 18 during a vehicle turn, an opposite laterally directed force is imparted to the rollers 56 by resistance with the ground. It is this lateral resistance between the rollers 56 and the ground which contributes to scuffing of the turf. However, since the force required to steer or turn the cutting unit 12 is reduced by the longer lever arm of the present invention, the lateral forces encountered by the rollers 56 due to ground resistance will be correspondingly reduced. Scuffing is thereby reduced by providing a longer effective lever arm for turning the cutting units 12.

In other words, if the longitudinal dimension between the upright steering shaft 30 and the cutting unit 12 were shorter, as is the case with many conventional reel mower mechanisms, then the effective lever arm would be smaller and the force that would have to be imparted to the front of the yoke in order for a moment of sufficient magnitude to be imparted to the cutting unit for steering the cutting unit would be larger. This larger lateral force would be resisted by a generally equal and opposite force at the contact between the ground and the rollers. This resistance force would therefore be larger than if a longer lever arm as shown in FIGS. 1 and 2 were utilized, and the scuffing of the turf would be correspondingly and undesirably increased due to the presence of a shorter lever arm. Therefore, the larger longitudinal dimension of the yoke 18 according to the preferred embodiment of the present invention acts to decrease the scuffing of the ground at the cutting unit's rollers 56.

The particular embodiment shown in FIGS. 1-3 provides a yoke 18 which extends rearwardly to establish a horizontal spacing of about 305 mm between the upright steering shaft 30 and the point at which the yoke 18 is coupled with the cutting unit 12. A horizontal spacing of about 257 mm is established between the upright steering shaft 30 and the axis of the front roller 56. The horizontal distance between the upright steering shaft 30 and the axis 58 of the cylindrical cutting reel 60, as best seen in FIG. 3, is 411 mm.

The inclined pivot means 40 of the preferred embodiment also acts to reduce turf scuffing during vehicle turns. As discussed earlier, conventional reel mowers often provide a horizontally and longitudinally extending pivot axis about which a yoke and cutting unit pivot to maintain proper ground contact when the cutting unit encounters side slopes. The laterally directed ground resistance forces encountered by the rollers during a turn act to pivot the cutting unit about these conventional horizontal pivot mechanisms, thereby forcing the edge of the cutting unit which is on the inside of the turn downwardly into the ground, and lifting the edge of the cutting unit which is on the outside of the turn off the ground. On conventional reel mowers, the height of a horizontal pivot axis above the rollers establishes a relatively large moment arm or lever arm such that the moment which forces the edge of the cutting unit down into the ground is relatively large. An undesirable amount of scuffing can therefore be caused by conventional pivot mechanisms.

The present invention provides a pivot axis 62 which is inclined to extend proximate the rollers 56 such that the effective moment arm or lever arm between the laterally directed ground resistance forces and the inclined pivot axis 62 is relatively small. Since the effective lever arm is relatively small, the moment which urges or forces the cutting unit 12 to pivot about the inclined shaft 42 is relatively small. The inside lateral edge of the cutting unit 12 during a turn is therefore forced downwardly against the ground to a lesser extent than if a horizontal pivot shaft were utilized, since the effective lever arm according to the present invention is smaller.

As seen in FIG. 3, the present invention provides an inclined pivot axis 62 which extends downwardly and rearwardly toward the cutting unit 12 at approximately a forty-five degree (45°) angle. More particularly, the inclined pivot axis 62 extends between the front and rear rollers 56.

The present invention acts to reduce the lateral ground resistance forces encountered by the rollers 56 during execution of a turn due to the longer effective lever arm established between the upright steering shaft 30 and the cutting unit rollers 56. Since smaller lateral forces are experienced by the rollers 56, the cutting unit 12 has less tendency to pivot about the inclined shaft 42, and the tendency of the inside edge of the cutting unit

12 to dig into the ground is reduced. The inclined shaft 42 further reduces the negative effects of the lateral ground forces. The axis 62 of the inclined pivot shaft 42 extends proximate the rollers 56 such that a relatively small effective lever arm is established. Therefore, the lateral ground forces—which are applied to the rollers 56 and are relatively small due to the operation of the longer lever arm between the cutting unit 12 and the upright shaft 30—are applied with a smaller effective lever arm. The tendency for the cutting unit 12 to swing about the inclined pivot axis 62 is thereby reduced due to the smaller lever arm. The cutting unit's lateral edge which is on the inside during a vehicle turn therefore dips or digs into the ground less aggressively. It is apparent then, that the preferred embodiment of the present invention reduces scuffing of the turf by the combined effect of two methods: first by providing a substantially lengthened effective lever arm between the upright steering pivot axis and the cutting unit 12, and second by providing a shortened effective lever arm between the cutting unit 12 and the inclined pivot axis 62.

I claim:

1. A mechanism for coupling a ground engaging cutting unit with a vehicle, comprising:

an inclined pivot mechanism having an axis and being coupled between the cutting unit and the vehicle for allowing the cutting unit to pivot about the axis as uneven ground conditions are encountered, said axis being inclined and extending downwardly and rearwardly generally toward the cutting unit, and

wherein said axis of the inclined pivot mechanism extends proximate the cutting unit's engagement with the ground for reducing te tendency of lateral edges of the cutting unit to press downwardly against the ground during execution of a turn.

2. The invention of claim 1, wherein the axis extends between front and rear rollers of the cutting unit.

3. The invention of claim 1, wherein the axis extends at approximately a forty-five degree angle.

4. The invention of claim 1, wherein:

the cutting unit further includes front and rear roller means which engage the ground.

5. A mechanism for coupling a ground engaging cutting unit with a vehicle, said cutting unit including lateral edge portions and front and rear roller means, said mechanism comprising:

an inclined pivot mechanism having an axis and being coupled between the cutting unit and the vehicle for allowing the cutting unit to pivot about said axis as the cutting unit encounters side slopes, said axis being inclined and extending downwardly and rearwardly toward the cutting unit and between the front and rear roller means for reducing the tendency of the lateral edge portions of the cutting unit to press downwardly against the ground during execution of a turn.

6. A mechanism for coupling a cutting unit with a vehicle, said cutting unit including front and rear ground engaging rollers and lateral edge portions, said mechanism comprising:

a yoke means coupled with the cutting units,

an inclined pivot means coupled between the yoke means and the vehicle for allowing the yoke and cutting unit thereattached to pivot with respect to the vehicle as side slopes are encountered, said inclined pivot means having an inclined axis of pivot which extends downwardly and rearwardly generally toward the cutting unit for reducing the tendency of the lateral edge portions of the cutting unit to press downwardly against the ground during execution of a turn.

7. The invention of claim 6, wherein the axis extends generally between the front and rear roller means.

8. The invention of claim 6, wherein the yoke means includes a front portion coupled with the inclined pivot means and a rear portion longitudinally spaced from the front portion and coupled with the cutting unit.

9. A mechanism for coupling a ground engaging cutting unit with a vehicle, comprising:

a generally upright steering pivot means operatively carried by the vehicle, and to which the cutting unit is operatively coupled, said upright steering pivot means having a generally upright axis about which the cutting unit may swing laterally as the vehicle executes a turn, said upright axis being spaced a substantial distance forward from the cutting unit, and

an inclined pivot means for allowing the cutting unit to pivot laterally about the axis as uneven ground conditions are encountered, said inclined pivot means having a pivot axis which extends downwardly and rearwardly generally toward the cutting unit.

10. The invention of claim 9, wherein the axis of the inclined pivot extends between front and rear rollers of the cutting unit.

11. The invention of claim 9, wherein the axis of the inclined pivot extends at approximately a forty-five degree angle.

12. The invention of claim 9, wherein the axis of the inclined pivot means extends proximate the cutting unit for reducing the distance between the axis and front and rear rollers for reducing the tendency of lateral edges of the cutting unit to press downwardly against the ground during execution of a turn.

13. The invention of claim 9, and further comprising a yoke having a front portion operatively coupled with the upright steering pivot means and the inclined pivot means, said yoke having a rear portion longitudinally spaced a substantial distance from the front portion of the yoke and operatively coupled with the cutting unit.

14. The invention of claim 9, wherein the inclined pivot means is coupled with the upright steering means for swinging laterally about the axis of the upright pivot means.

15. The invention of claim 9, wherein:

the upright steering pivot means further includes a pivot member pivotable about the generally upright axis, and

said inclined pivot means is coupled with the pivot member for swinging about the upright axis with the pivot member.

16. The invention of claim 9, further comprising:

a generally upright shaft means,

a pivot member having a first opening for receiving the upright shaft, said pivot member being pivotable about the upright shaft,

an inclined shaft extending downwardly and rearwardly from the pivot member, and

a yoke means coupled with the cutting unit, said yoke means including an inclined opening for receiving the inclined shaft, said yoke and cutting unit being pivotable about the inclined shaft.

17. A mechanism for coupling a ground engaging cutting unit with a vehicle, said cutting unit including

lateral edge portions and front and rear roller means, said mechanism comprising:

a generally upright steering pivot means operatively carried by the vehicle and spaced a substantial distance forward of the cutting unit for allowing the cutting unit to swing laterally about and generally follow the steering pivot when relatively small lateral ground forces are encountered by the front and rear roller means as the vehicle executes a turn and for reducing lateral forces encountered by the front and rear roller means during a turn, and

an inclined pivot means operatively coupled between the cutting unit and the vehicle for allowing the cutting unit to pivot about said axis as side slopes are encountered, said inclined pivot means having a pivot axis extending downwardly and rearwardly between the front and rear rollers for reducing the tendency of the lateral edge portions of the cutting unit to press downwardly against the ground during execution of a turn.

18. The invention of claim **17**, and further comprising a yoke having a front portion operatively coupled with the upright steering pivot means and the inclined pivot means, said yoke having a rear portion longitudinally spaced a substantial distance from the front portion of the yoke and operatively coupled with the cutting unit.

19. The invention of claim **18**, wherein the axis of the inclined pivot extends at approximately a forty-five degree angle.

20. A mechanism for coupling a ground engaging cutting unit with a vehicle, comprising:

an inclined pivot mechanism having an axis and being coupled between the cutting unit and the vehicle for allowing the cutting unit to pivot about the axis as uneven ground conditions are encountered, said axis being inclined and extending downwardly and rearwardly generally toward the cutting unit, and

wherein the axis extends between front and rear rollers of the cutting unit.

21. A mechanism for coupling a ground engaging cutting unit with a vehicle, comprising:

an inclined pivot mechanism having an axis and being coupled between the cutting unit and the vehicle for allowing the cutting unit to pivot about the axis as uneven ground conditions are encountered, said axis being inclined and extending downwardly and rearwardly generally toward the cutting unit, and

wherein said axis extends at approximately a forty-five degree angle.

22. A mechanism for coupling a ground engaging cutting unit with a vehicle, comprising:

an inclined pivot mechanism having an axis and being coupled between the cutting unit and the vehicle for allowing the cutting unit to pivot about the axis as uneven ground conditions are encountered, said axis being inclined and extending downwardly and rearwardly generally toward the cutting unit,

wherein the cutting unit further includes front and rear roller means, and

the axis of the inclined pivot mechanism extends proximate the cutting unit to reducing the distance between the axis and the front and rear rollers for reducing the tendency of lateral edges of the cutting unit to press downwardly against the ground during execution of a turn.

* * * * *

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Smith

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[54] SUSPENSION MECHANISM FOR REEL MOWERS

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[52] U.S. Cl. 56/7; 56/11.9; 56/15.9; 56/DIG. 22

[58] Field of Search ..... 56/6, 7, 14.9, 15.9, 56/16.3, DIG. 22, 228, 11.9

[56] References Cited

U.S. PATENT DOCUMENTS

1,900,726	3/1993	Moyer	56/7
3,824,772	7/1974	Sorenson et al.	56/7
4,178,741	12/1979	Lonn et al.	56/7
4,370,846	2/1983	Arnold	56/6
4,769,976	9/1988	Bassett et al.	56/7
4,864,805	9/1989	Hager et al.	56/11.9
5,042,236	8/1991	Lamusga et al.	56/7
5,146,733	9/1992	Klaeger	56/6

FOREIGN PATENT DOCUMENTS

159259	2/1979	Netherlands	56/7
1606738	11/1981	United Kingdom .	
2151446	7/1985	United Kingdom .	

OTHER PUBLICATIONS

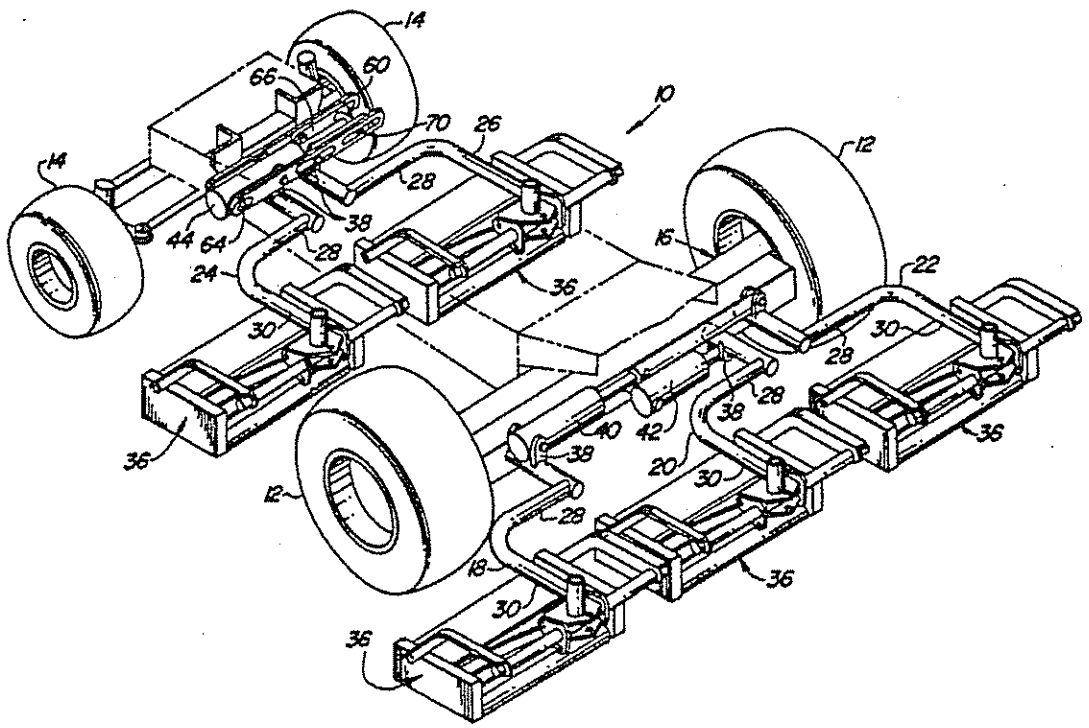
Sales brochure entitled: "Toro Reelmaster 223-D"; published in 1990 by The Toro Company, front cover and p. 1.

Primary Examiner—David J. Bagnell

[57] ABSTRACT

A suspension mechanism for a reel mower vehicle, having arm members coupled between a vehicle and a cutting unit, a lever member coupled with each arm member, and a hydraulic cylinder coupled the lever member. A hydraulic circuit actuates the cylinders for lifting the arm members and cutting units to a transport position. A variable restriction valve is provided for causing the cylinders to apply a downforce to the arm members and cutting units for securing the cutting units against the ground over irregular ground conditions, and is adjustable for varying the magnitude of the downforce.

23 Claims, 4 Drawing Sheets



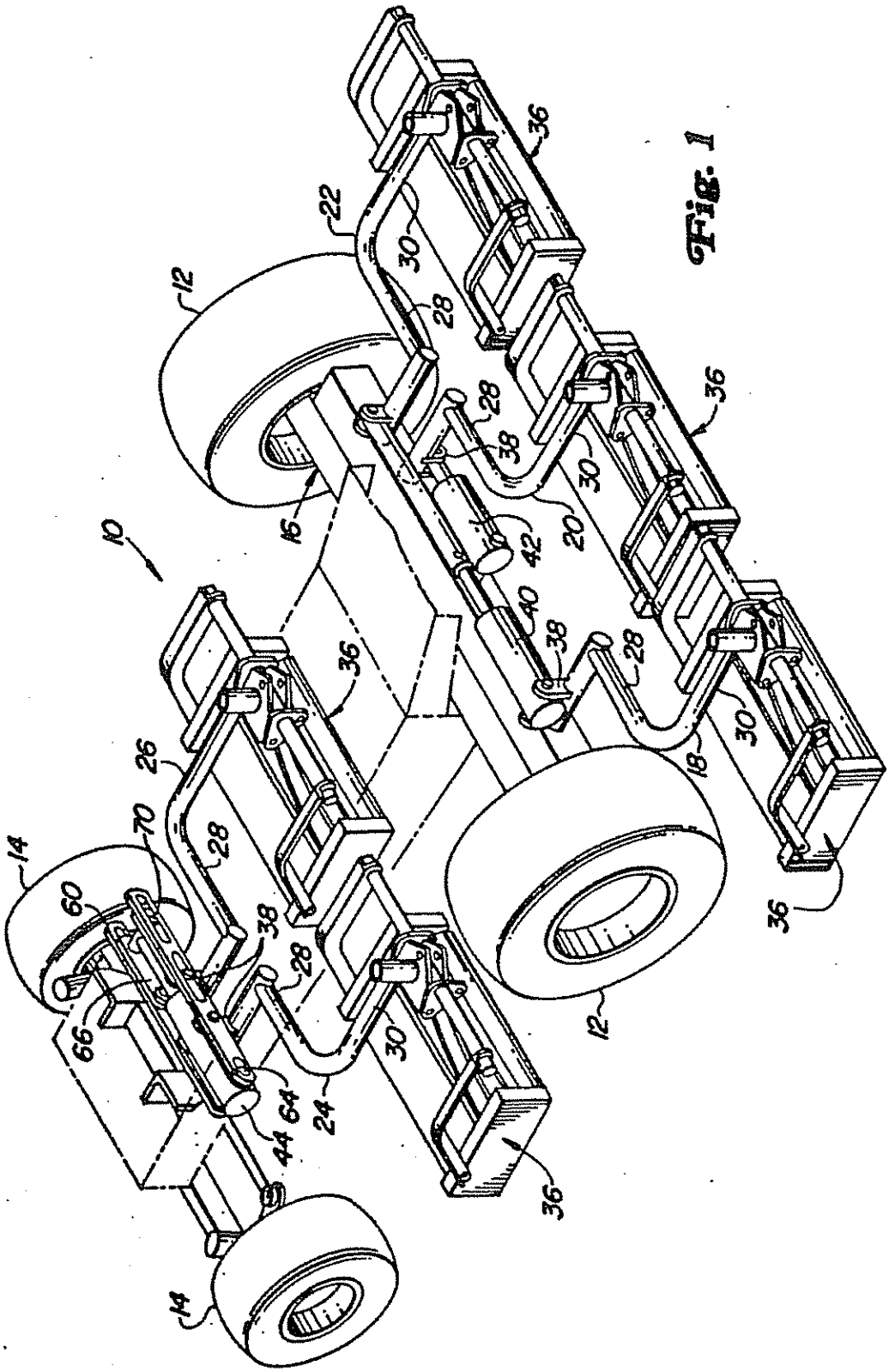


Fig. 1

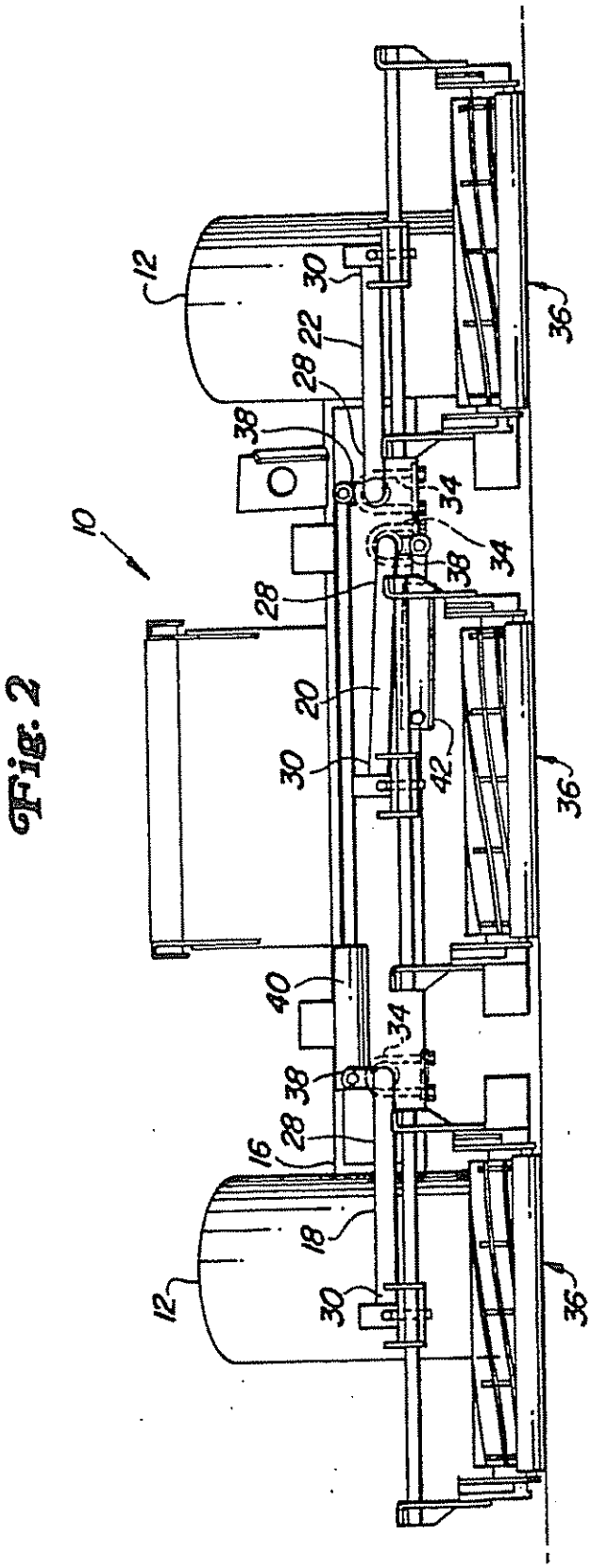
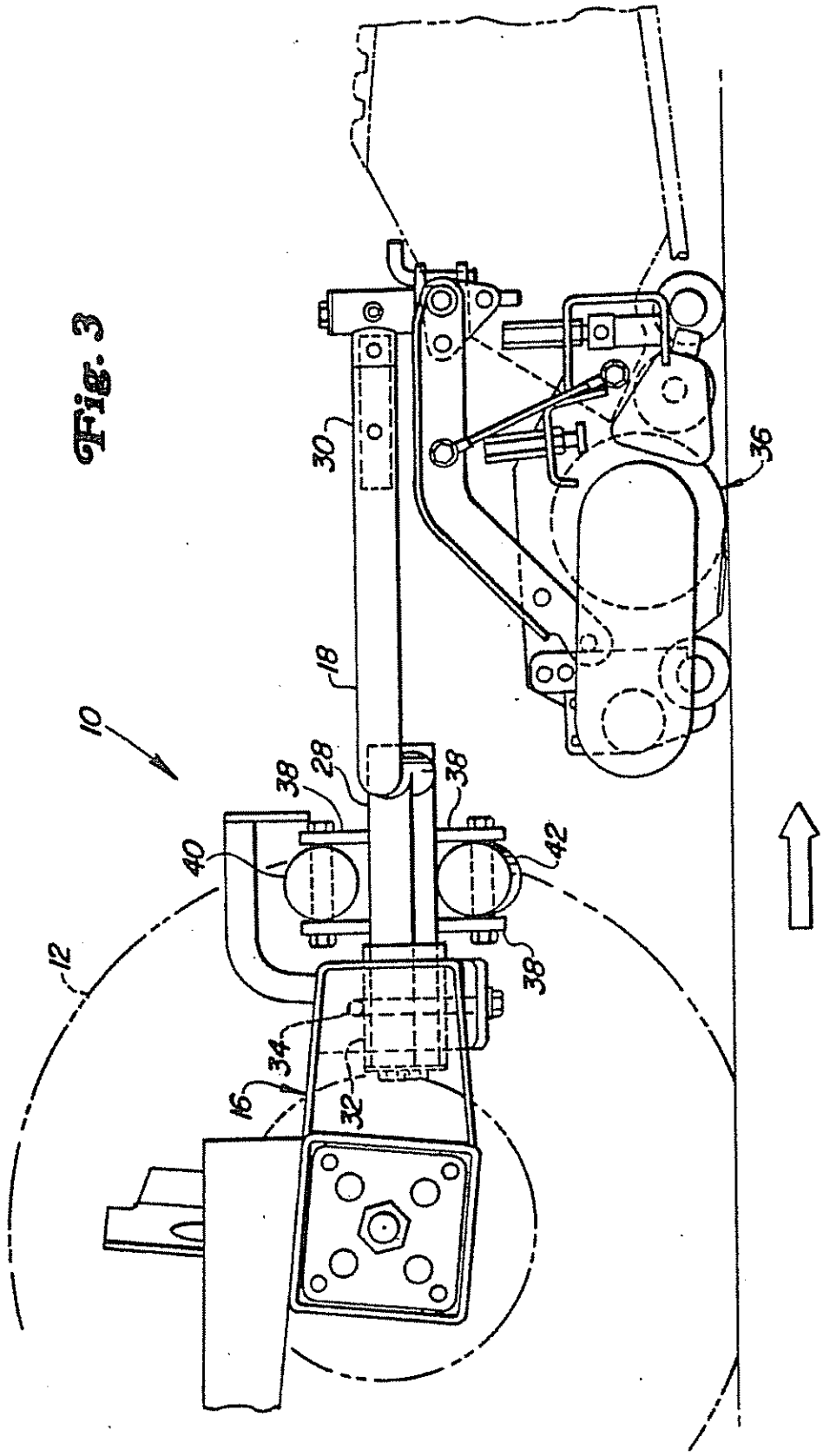


Fig. 2

Fig. 3



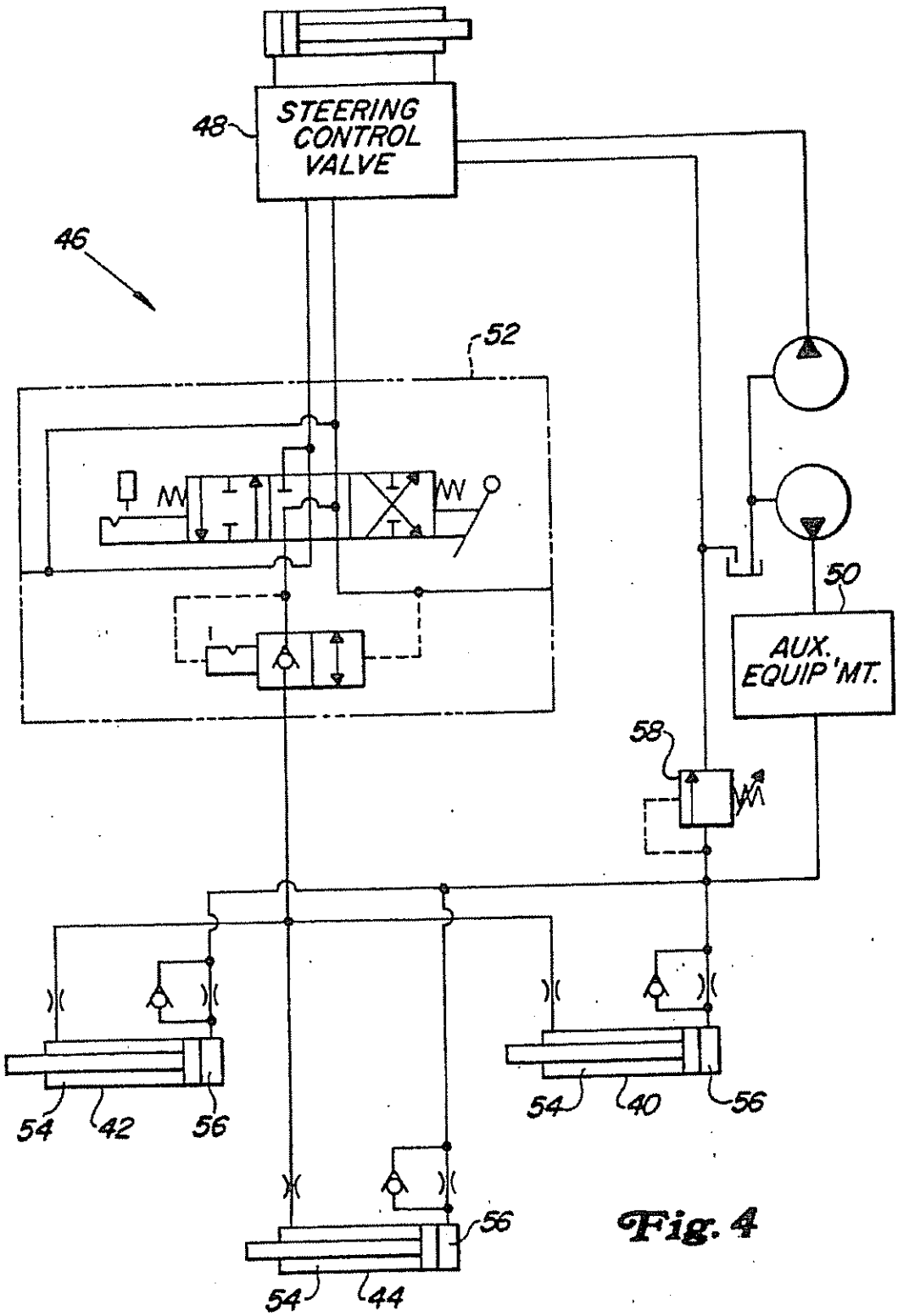

STEERING CONTROL VALVE
48
46
52
50
AUX. EQUIP'MT.
58
54
42
56
54
40
56
56
54
44

Fig. 4

SUSPENSION MECHANISM FOR REEL MOWERS

BACKGROUND OF THE INVENTION

This invention relates to reel mower cutting units and the mechanisms that attach reel mowers to vehicles. Conventional reel mower vehicles include a plurality of arm members that extend from the vehicle, each arm having a reel-type cutting unit attached to its outer end portion. The reel-type cutting units typically include front and rear rollers that carry the cutting units across the surface of the ground during mowing operation. The blades of the rotating reel interact with a bedknife to cut grass or other vegetation with a scissoring action.

Many conventional mowing vehicles allow the weight of the cutting unit and arm to maintain the cutting unit in contact with the ground during mowing operations. However, when relatively high traveling speeds are achieved during mowing operations, the cutting unit can tend to bounce up or rise out of contact with the ground when irregular ground conditions are encountered. In an attempt to reduce bouncing of the cutting unit, springs have been coupled between the vehicle and the arm member for pressing the arm down and thereby biasing the cutting unit against the ground. However, conventional spring downloading mechanisms have several disadvantages. The force exerted by the springs will vary as the length of the spring changes. Therefore, as the cutting unit and arm shift up and down relative to the vehicle as ground irregularities or bumps are encountered, the spring will stretch or contract, resulting in a varying downforce being applied. The height at which the grass is cut can be affected by the difference in downforce applied by the spring, and the quality of cut may be adversely affected. Also, in order to adjust the amount of the downforce to adapt to different mowing conditions, mowing operations must be stopped, and the length of the spring must be adjusted. Therefore, springs used to supply downforce to arm members generally do not allow for adjustments "on-the-go", and require mowing operations to be interrupted for adjustment of the downforce. An additional disadvantage of spring downloading mechanisms is that, if they are adjustable for varying the magnitude of the downforce, the range within which they are adjustable is relatively small, since a particular spring can only be compressed or extended so far. Springs may also tend to add manufacturing and assembly costs to the vehicle.

It would therefore be desirable to provide a mechanism for coupling a cutting unit with a vehicle, and that is adapted to both lift the cutting units during transport, and to press the cutting unit downwardly against the ground during mowing operations. It would be desirable for such a mechanism to provide a constant downforce to the cutting units during mowing operations such that the cut quality is enhanced. Furthermore, it would be desirable for an operator of such a mechanism to be able to make adjustments during mowing operations to change the amount of downforce imparted to the cutting units without interrupting the forward travel of the vehicle. It would also be desirable for such a mechanism to be capable of being manufactured and assembled at relatively low cost.

SUMMARY OF THE INVENTION

The preferred embodiment of the present invention includes an arm member coupled between a vehicle and a cutting unit. A hydraulic cylinder is coupled with a lever member which is coupled with the pivotal arm member. The cylinders are coupled with a hydraulic circuit that allows the operator to actuate the cylinders for lifting the arm members to a transport position whereat the cutting units are held a distance above the ground. The operator can also control the hydraulic circuit to cause the cylinders to apply a downforce to the arm members, thereby urging the cutting units toward and against the ground. The hydraulic circuit according to the present invention includes a variable restriction valve which can be controlled by the operator for infinite adjustment of the downforce over a relatively large range. The variable restriction valve may be positioned in the operator station to allow the operator to adjust the amount of downforce without interrupting mowing operations.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial perspective view of a mowing vehicle according to the preferred embodiment of the present invention.

FIG. 2 is a front view of the mowing vehicle.

FIG. 3 is a side view of the front portion of the mowing vehicle.

FIG. 4 is a schematic diagram of the hydraulic circuit used in the preferred embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to FIG. 1, there is shown a mowing vehicle 10 according to the preferred embodiment having a pair of front driven wheels 12 and a pair of rear steerable wheels 14. A rigid support structure or single frame 16 extends laterally between the front pair of wheels 12, and generally longitudinally between the front and rear pair of wheels 12 and 14. A plurality of arm means 18, 20, 22, 24 and 26 extend outwardly from the frame 16, and include inner and outer end portions 28 and 30. The inner portions 28 are pivotally carried within bushings 32 which are secured to the frame 16 via U-shaped members 34. The outer end portions 30 are adapted for being operatively coupled with reel mower cutting units 36.

The inner end portions 28 of each arm include a lever member 38 rigidly coupled thereto. According to the preferred embodiment and as seen in FIG. 1, a first hydraulic cylinder 40 is coupled between the lever members of the front outer arms 18 and 22. A second hydraulic cylinder 42 is coupled between the lever member 38 of the front inner arm 20 and a portion of the frame 16. A third hydraulic cylinder 44 is coupled between the lever members 38 of the rear pair of arms 24 and 26. As the hydraulic cylinder mechanisms 40, 42 and 44 contract, the lever members 38 are rotated such that the arm members 18, 20, 22, 24 and 26 thereattached are lifted. As the hydraulic cylinders 40, 42 and 44 expand, the lever members 38 rotate about respective pivot bushings 32 in such a manner that the respective arms are pressed toward the ground. The force applied to the arms 18–26 via the cylinders 40, 42, 44 and lever members 38 acts to press the cutting units 36 downwardly, thereby maintaining the cutting units 36 in contact with the ground when mowing on bumpy or irregular terrain.

Referring now to FIG. 4, there is shown a schematic representation of the hydraulic circuit 46 used in the preferred embodiment of the present invention. The fluid circuit 46 powers the steering mechanism 48, and also auxiliary mechanisms 50 such as the hydraulic motors which provide power to the reels in the cutting units. The circuit 46 according to the preferred embodiment is also coupled with the three hydraulic cylinders 40, 42, 44. A control valve 52 forms a part of the circuit 46, and can be shifted by the operator for forcing hydraulic fluid into the rod end 54 of the cylinders 40, 42, 44 for lifting the arms 18–26 coupled with the cylinders. The control valve 52 can also be selectively shifted by the operator to allow fluid to flow out of the rod ends 54 of the cylinders 40, 42, 44, which will cause the cylinders to expand and rotate the lever members 38 and arms 18–26 about the pivot mechanism for allowing the cutting units 36 to move to the ground. A variable restriction valve 58 is also provided as part of the hydraulic circuit 46 of the preferred embodiment. The restriction caused by the valve 58 creates a back-pressure in the circuit 46, which will tend to maintain a generally constant pressure in the base end 56 of the cylinders 40, 42, 44 thereby sustaining the downforce on the cutting units 36. The operator can vary the degree of restriction in the valve 58 to adjust the amount of downforce applied to the cutting unit 36 by the cylinders 40, 42, 44.

Referring to FIG. 1, there is shown the mechanism for attaching the third cylinder 44 to the rear lever members 38. A pair of rail members 60 are pivotally coupled with the lever members 38 of the right rear arm 24. A slotted opening is provided in the rail 60 for receiving a pin 64 carried by the base end 56 of the third cylinder 44. A pair of link members 66 are coupled with the lever members 38 of the left rear arm 26. A slotted opening is provided in the link member 66 for receiving a pin 70 carried by the rod of the third cylinder mechanism 44. As the third cylinder mechanism 44 expands, the pins 64 and 70 move apart from each other, and the rail member 60 and link member 66 cause the respective rear lever members 38 to pivot outwardly away from each other. The rear arms 24 and 26 thereby urge the rear cutting units 36 toward the ground. As the third cylinder 44 retracts, the pins 64 and 70 shift toward each other, and the links 66 and rails 60 act to pivot the respective rear lever members 38 toward each other. The rear arms 24 and 26 are thereby lifted to a transport position. The openings formed in the rail 60 and link members 66 for receiving the pins 64 and 70 are slotted or elongated to provide a lost motion function, and therefore cause the rear arms 24 and 26 to be lifted a short time period after the front lift arms 18, 20 and 22 have been lifted. In other words, when the operator initiates the lift operation, the front arms 18, 20 and 22 begin lifting the front cutting units 36, and the rear arms 24 and 26 remain in a lowered position until the pins 64 and 70 travel to the ends of the sloted openings. The rear arms 24 and 26 then begin to lift. As an operator approaches the boundry of the fairway or other area being moweed, he initiates the lift operation as the front cutting units are about to reach the boundry. As the vehicle 10 continues traveling forward, the front cutting units are lifted and the rear units remain on the ground in cutting position. The sequencing feature of the sloted openings acts to raise the rear cutting units when they get closer to the boundry. The other slots formed in the rails 60 slidably receive the pin 70 and lever member 38 of the left rear arm 26, and merely serve to maintain the third cylinder mechanism 44 in level alignment throughout the cylinder's range of expansion and retraction.

The hydraulic cylinders 40, 42, 44 according to the present invention provide both a lifting force and a downward force to the cutting units 36. By serving both functions, extra structure such as downloading springs are eliminated. The cost of manufacturing and assembling the mechanism is correspondingly reduced. Furthermore, the downforce applied by the present invention can be adjusted by the operator by manipulating the variable restriction valve 58. The variable restriction can be adjusted during forward travel of the vehicle 10, and therefore allows for adjustment of the downforce without interruption of mowing operations. The use of cylinders allows the downforce to be adjusted over a relatively large range. The upper limit of the downforce the cylinder can transfer to an arm is dependent on such factors as the amount of pressure the hydraulic pump can generate, and the amount of pressure the cylinder and other componentry of the hydraulic circuit can withstand. Spring downforce mechanisms on the other hand, only allow a relatively small range of adjustments, since a particular spring can only be extended or compressed so far.

Furthermore, the variable restriction valve 58 according to the present invention allows the operator to infinitely adjust the amount of downforce applied to the cutting units 36 by the cylinders 40, 42 and 44. The fine degree of adjustment provided by the present invention allows the operator to select a downforce that is precisely suited for the particular operating conditions. Also, the use of hydraulic cylinders 40, 42 and 44 allows the downforce to remain relatively constant even when the arms 18, 20, 22, 24 and 26 rise up and down over ground undulations. The pressure in the base end 56 of the cylinders will remain generally constant regardless of the position of the pistons within the cylinders, and therefore the downforce will remain generally constant. The preferred embodiment uses a single variable restriction valve 58 for creating the backpressure in the base ends 56 of all three cylinders 40, 42, 44, which are arranged in parallel. The number of parts is thereby reduced, and the cost of manufacture and assembly of the mechanism is correspondingly reduced. Furthermore, since a single restrictor valve 58 is used, the operator is able to adjust the downforce applied to the cutting units with a single operation.

The preferred embodiment of the present invention provides cylinders 40, 42, 44 which are coupled at 90° angles with the lever members 38. The moment arm created as the cylinder 40, 42 or 44 applies a force to the lever arm 38 is therefore maximized, and less force is required to shift or bias the arms. As the cutting units 36 shift up or down as ground undulations are encountered, the lever member 38 will pivot to a position that is not 90° with the cylinder. However, since the lever member 38 was at 90° with the cylinder when on level ground, the lever member 38 will only shift a small angle from the desired or ideal 90° when bumps or dips in the ground are encountered. The moment arm therefore remains relatively large even when undulations are encountered, and the force that must be applied to the lever member 38 by the cylinder to yield a given downloading is relatively small. Since the hydraulic cylinders are only required to apply a relatively small force, smaller, less costly cylinders and hydraulic componentry can be used.

The preferred embodiment shows only three hydraulic cylinders 40, 42 and 44 for applying force to a total of five cutting units 36. The rear cylinder 44 extends directly between the lever members 38 of the rear arms 24 and 26, as opposed to a pair of rear cylinders being coupled between respective rear lever arms 38 and the frame 16. The use of a single rear cylinder 44 that extends between the lever members 38 of the rear arms 24 and 26 therefore reduces the number of cylinders required to accomplish the lifting and downloading functions. The cost of manufacturing and assembling the vehicle is therefore reduced. Similarly, the outer front arms 18 and 22 have a single hydraulic cylinder 40 coupled between the outer lever members 38 for affecting the lifting and downloading functions. However, the vehicle could be provided with five cylinders, with each lever arm 38 having a different cylinder attached to it. If five cylinders are used, then one end of each cylinder would be coupled with the frame 16 instead of another lever member 38.

The preferred embodiment shows hydraulic cylinders 40, 42 and 44 that are extendable to provide downforce to the cutting units 36, and are retractable to lift the cutting units 36 to a transport mode. However, the present invention could also be provided with lever members or cylinders positioned in different configurations than those shown, such that the mechanism would retract to provide a downforce and extend to lift the cutting units.

I claim:

1. A mechanism for attaching a cutting unit to a vehicle, comprising:

an arm means having a first end portion coupled with the vehicle, said arm means having a second end portion adapted for shifting up and down with respect to the vehicle,

a cutting unit operatively coupled to the second end portion and engagable with the ground, and

a hydraulic cylinder means operatively coupled between the arm means and the vehicle for selectively applying a force to the arm means to urge the second end portion of the arm means downwardly for pressing the cutting unit against the ground during cutting operations, said cylinder means also being adapted for lifting the second end portion of the arm means for selectively lifting and maintaining the cutting unit above the ground during vehicle transport.

2. The invention of claim 1, wherein the cutting unit is a reel mower.

3. The invention of claim 1, wherein the cylinder means applies a generally constant force to the arm means regardless of the pivotal position of the arm means due to undulations in ground contour.

4. The invention of claim 1, and further comprising means for adjusting the force exerted by the cylinder means on the arm means during operation of the vehicle.

5. The invention of claim 4, wherein said adjusting means is an infinitely adjustable, variable restriction valve.

6. The invention of claim 4, and further comprising:

a hydraulic circuit coupled with the cylinder, and

said control means further comprises a variable restriction valve coupled with the hydraulic circuit and selectively adjustable to vary the downforce applied by the cylinder to the arm means and cutting unit.

7. The invention of claim 6, wherein the variable restriction valve is infinitely variable.

8. The invention of claim 1, wherein the cylinder means applies a generally constant force to the arm means regardless of the pivotal position of the arm means due to ground undulations, and

means is provided for adjusting the force exerted by the cylinder means on the arm means during operation of the vehicle.

9. The invention of claim 1, wherein the cylinder means is extended to urge the second end portion of the arm means and the cutting unit toward the ground, and is retracted to lift the cutting unit above the ground.

10. A mechanism for attaching a cutting unit to a vehicle, comprising:

a pair of arm means coupled with the vehicle and extending from the vehicle in generally opposite directions, each of said arm means having a first end portion pivotally coupled with the vehicle, and a second end portion opposite the first end portion,

a pair of cutting units operatively coupled with the second end portion of the arm means and engagable with the ground during operation, and

a hydraulic cylinder means coupled with and extending between the pair of arm means and selectively operable to lift both arm means to a transport position with the cutting units lifted from the ground, said cylinder also being selectively operable to urge the second portions of each arm means downwardly during operation for urging the second end portions and cutting units toward the ground.

11. The invention of claim 10, wherein the cylinder means applies a generally constant force to both arm means regardless of the pivotal position of the arm means due to undulations in ground contour.

12. The invention of claim 10, and further comprising means for adjusting the force exerted by the cylinder means on the arm means during operation of the vehicle.

13. The invention of claim 12, and further comprising:

a hydraulic circuit coupled with the cylinder, and

said adjusting means further comprises a variable restriction valve coupled with the hydraulic circuit and selectively adjustable to vary the downforce applied by the cylinder to the arm means and cutting unit.

14. The invention of claim 10, wherein the cylinder means applies a generally constant force to both arm means' regardless of the pivotal position of the arm means' due to ground undulations, and

means is provided for adjusting the force exerted by the cylinder means on the arm means during operation of the vehicle.

15. The invention of claim 10 wherein the cylinder means extends to urge the second end portion of both arm means and the cutting units toward the ground, and retracts to lift both cutting units above the ground.

16. A mowing vehicle, comprising:

a pair of front wheels,

at least one rear wheel,

a frame extending between the pair of front wheels, and extending between the front wheels and the rear wheel,

three front arm means pivotally coupled with the frame generally between the front wheels, said front arms extending generally forwardly from the vehicle for being coupled with cutting units, and

including two outer arm means and an inner arm means,

lever members coupled with each arm means,

a first hydraulic cylinder extends between the lever members of the outer arm members, said first hydraulic cylinder being shiftable for lifting the outer arm means and for urging the outer arm means to pivot toward the ground,

a second hydraulic cylinder means coupled between the frame and the lever member of the inner arm means, said hydraulic cylinder being shiftable for lifting the inner arm means and for urging the inner arm means to pivot toward the ground to urge the cutting units against the ground.

17. The invention of claim 16, and further comprising:

a rear pair of arm means pivotally carried by the frame at a location generally to the rear of the front arm means, said rear arms each being coupled with a respective rear cutting unit,

lever members coupled with each of the rear arm means,

a rear hydraulic cylinder coupled between the lever members of the rear arm means, said rear hydraulic cylinder being shiftable to lift both rear arm members and to urge both rear arm means toward the ground to urge the rear cutting units against the ground.

18. A mechanism for attaching a cutting unit to a vehicle, comprising:

an arm means having a first end portion coupled with the vehicle, said arm means having a second end portion opposite the first end portion and adapted for shifting up and down with respect to the vehicle,

a reel mower cutting unit being coupled to the second end portion and engagable with the ground, and

a hydraulic cylinder means operatively coupled between the arm means and the vehicle for selectively applying a force to the arm means to urge the second end portion of the arm means downwardly for pressing the cutting unit into engagement with the ground during cutting operations, said cylinder means applying a generally constant force to the arm means regardless of the pivotal position of the arm means due to undulations in ground contour, said cylinder means also being adapted for lifting the second end portion of the arm means for selectively lifting and maintaining the cutting unit above the ground during vehicle transport, and

means for adjusting the force exerted by the cylinder means on the arm means during operation of the vehicle.

19. A mechanism for attaching a cutting unit to a vehicle, comprising:

an arm means having a first end portion coupled with the vehicle, said arm means having a second end portion opposite the first end portion and adapted for shifting up and down with respect to the vehicle,

a reel mower cutting unit being coupled to the second end portion and engagable with the ground, and

a hydraulic cylinder means operatively coupled between the arm means and the vehicle for selectively applying a force to the arm means to urge the second end portion of the arm means downwardly for pressing the cutting unit into engagement with the ground during cutting operations, said cylinder means applying a generally constant force to the arm means regardless of the pivotal position of the arm means due to undulations in ground contour, said cylinder means also being adapted for lifting the second end portion of the arm means for selectively lifting and maintaining the cutting unit above the ground during vehicle transport, and

an infinitely adjustable, variable restriction valve for adjusting the force exerted by the cylinder means on the arm means during operation of the vehicle.

20. A mechanism for attaching a cutting unit to a vehicle, comprising:

an arm means having a first end portion coupled with the vehicle, said arm means having a second end portion opposite the first end portion and adapted for shifting up and down with respect to the vehicle,

a reel mower cutting unit being coupled to the second end portion and engagable with the ground, and

a hydraulic cylinder means operatively coupled between the arm means and the vehicle for selectively applying a force to the arm means to urge the second end portion of the arm means downwardly for pressing the cutting unit into engagement with the ground during cutting operations, said cylinder means applying a generally constant force to the arm means regardless of the pivotal position of the arm means due to undulations in ground contour, said cylinder means also being adapted for lifting the second end portion of the arm means for selectively lifting and maintaining the cutting unit above the ground during vehicle transport, and

means for adjusting the force exerted by the cylinder means on the arm means during operation of the vehicle.

21. A mechanism for attaching a cutting unit to a vehicle, comprising:

an arm means having a first end portion coupled with the vehicle, said arm means having a second end portion opposite the first end portion and adapted for shifting up and down with respect to the vehicle,

a reel mower cutting unit being coupled to the second end portion and engagable with the ground, and

a hydraulic cylinder means operatively coupled between the arm means and the vehicle for selectively applying a force to the arm means to urge the second end portion of the arm means downwardly for pressing the cutting unit into engagement with the ground during cutting operations, said cylinder means applying a generally constant force to the arm means regardless of the pivotal position of the arm means due to undulations in ground contour, said cylinder means also being adapted for lifting the second end portion of the arm means for selectively lifting and maintaining the cutting unit above the ground during vehicle transport, said cylinder means being extendable to urge the second end portion of the arm means and the cutting unit toward the ground and retractable to lift the cutting unit above the ground.

22. A mechanism for attaching a cutting unit to a vehicle, comprising:

an arm means having a first end portion coupled with the vehicle, said arm means having a second end portion opposite the first end portion and adapted for shifting up and down with respect to the vehicle,

a reel mower cutting unit being coupled to the second end portion and engagable with the ground, and

a hydraulic cylinder means operatively coupled between the arm means and the vehicle for selectively applying a force to the arm means to urge the second end portion of the arm means downwardly for pressing the cutting unit into engagement with the ground during cutting operations, said cylinder means applying a generally constant force to the arm means regardless of the pivotal position of the arm means due to undulations in ground contour, said cylinder means also being adapted for lifting the second end portion of the arm means for selectively lifting and maintaining the cutting unit above the ground during vehicle transport,

a hydraulic circuit coupled with the cylinder, and

a variable restriction valve coupled with the hydraulic circuit and selectively adjustable to vary the downforce applied by the cylinder to the arm means and cutting unit.

23. A mechanism for attaching a cutting unit to a vehicle, comprising:

an arm means having a first end portion coupled with the vehicle, said arm means having a second end portion opposite the first end portion and adapted for shifting up and down with respect to the vehicle,

a reel mower cutting unit being coupled to the second end portion and engagable with the ground, and

a hydraulic cylinder means operatively coupled between the arm means and the vehicle for selectively applying a force to the arm means to urge the second end portion of the arm means downwardly for pressing the cutting unit into engagement with the ground during cutting operations, said cylinder means applying a generally constant force to the arm means regardless of the pivotal position of the arm means due to undulations in ground contour, said cylinder means also being adapted for lifting the second end portion of the arm means for selectively lifting and maintaining the cutting unit above the ground during vehicle transport,

a hydraulic circuit coupled with the cylinder, and

a variable restriction valve coupled with the hydraulic circuit and selectively adjustable to infinitely vary the downforce applied by the cylinder to the arm means and cutting unit.

* * * * *

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United States Patent [19]

Reichen et al.

[11] Patent Number: 5,343,680

[45] Date of Patent: Sep. 6, 1994

[54] SUSPENSION MECHANISM FOR REEL MOWERS

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[73] Assignee: Deere & Company, Moline, Ill.

[21] Appl. No.: 940,418

[22] Filed: Sep. 3, 1992

[51] Int. Cl.[5] A01D 34/62

[52] U.S. Cl. 56/249; 56/7; 56/294

[58] Field of Search ..... 56/249, 7, 15.1, 15.2, 56/253, 294, DIG. 9, DIG. 11, DIG. 14

[56] References Cited

U.S. PATENT DOCUMENTS

3,410,063	11/1968	Speiser	56/7
3,514,926	6/1970	Heth et al.	56/7
3,613,337	10/1971	Akgulian et al.	56/7
3,616,626	11/1971	Bramley et al.	56/26
3,824,772	7/1974	Sorenson et al.	56/249 X
4,072,001	2/1978	Aldred	56/7
4,384,443	5/1983	Hoogstrate	56/11.9
4,711,072	12/1987	Aldred	56/6
4,769,976	9/1988	Bassett et al.	56/7
5,042,236	8/1991	Lamusga et al.	56/7
5,170,613	12/1992	Heise et al.	56/249

OTHER PUBLICATIONS

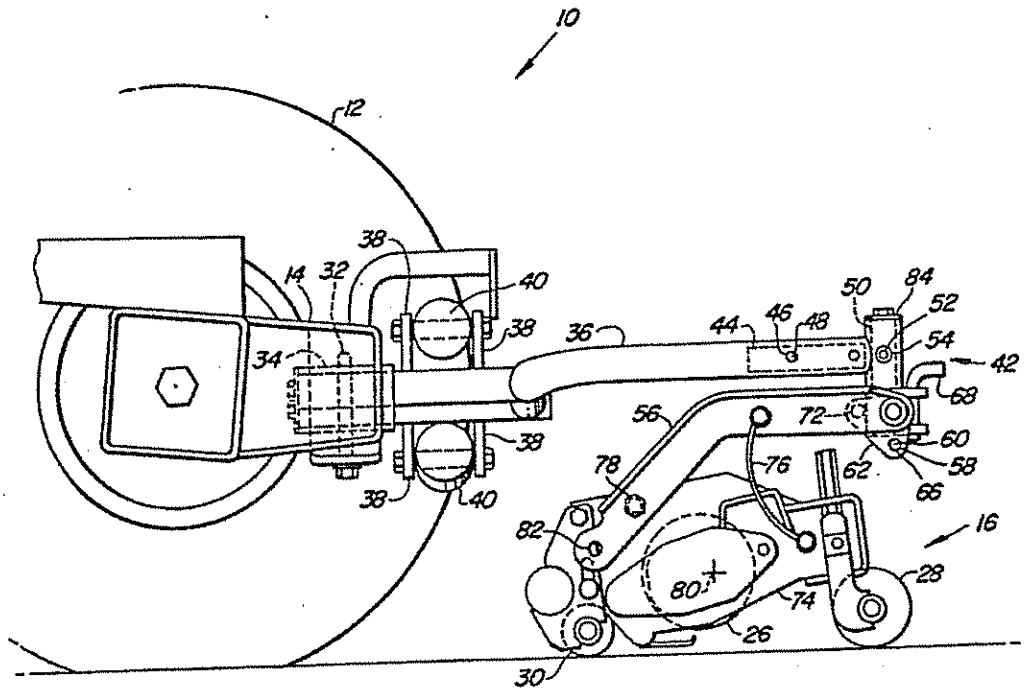
Brochure entitled: "Toro Reelmast 223-D" published by The Toro Company in 1990, pp. 1-8.
Brochure entitled "3325 Professional Turf Mower", published by Deere & Co. in 1990, pp. 1-4.
Brochure entitled "Toro Reelmaster 216", published by The Toro Company in 1990, pp. 1-4.
Brochure entitled "Toro Reelmaster 335-D", published by the Toro Company in 1990, pp. 1-4.
Brochure entitled "Jacobsen LF-100 Lightweight Mowering Quality With High Productivity", published by the Jacobsen Division of Textron in 1989, pp. 1-4.
Brochure entitled "Ransomes 220 M28-4WD" published by Ransomes Inc. in 1992, pp. 1 and 2.
Brochure entitled "Ransomes Fairway 5000 Mower" published by Ransomes Inc. in 1989, pp. 1-6.
Brochure entitled "Ransomes 300 M35-4WD" published by Ransomes Inc., in 1992, pp. 1 and 2.

Primary Examiner—Terry L. Melius

[57] ABSTRACT

A mechanism for shifting reel mower cutting units to a position whereat the undersides of the cutting units are exposed for service. A knuckle joint is provided for pivoting the cutting units as the lift arms are raised to thereby shift the cutting units to service positions. A connection point is provided between a yoke and the cutting unit which is located at the upper rear quadrant of the cutting unit's side frame for generally balancing the force distributed to the ground through the front and rear rollers during forward mowing operations.

35 Claims, 9 Drawing Sheets



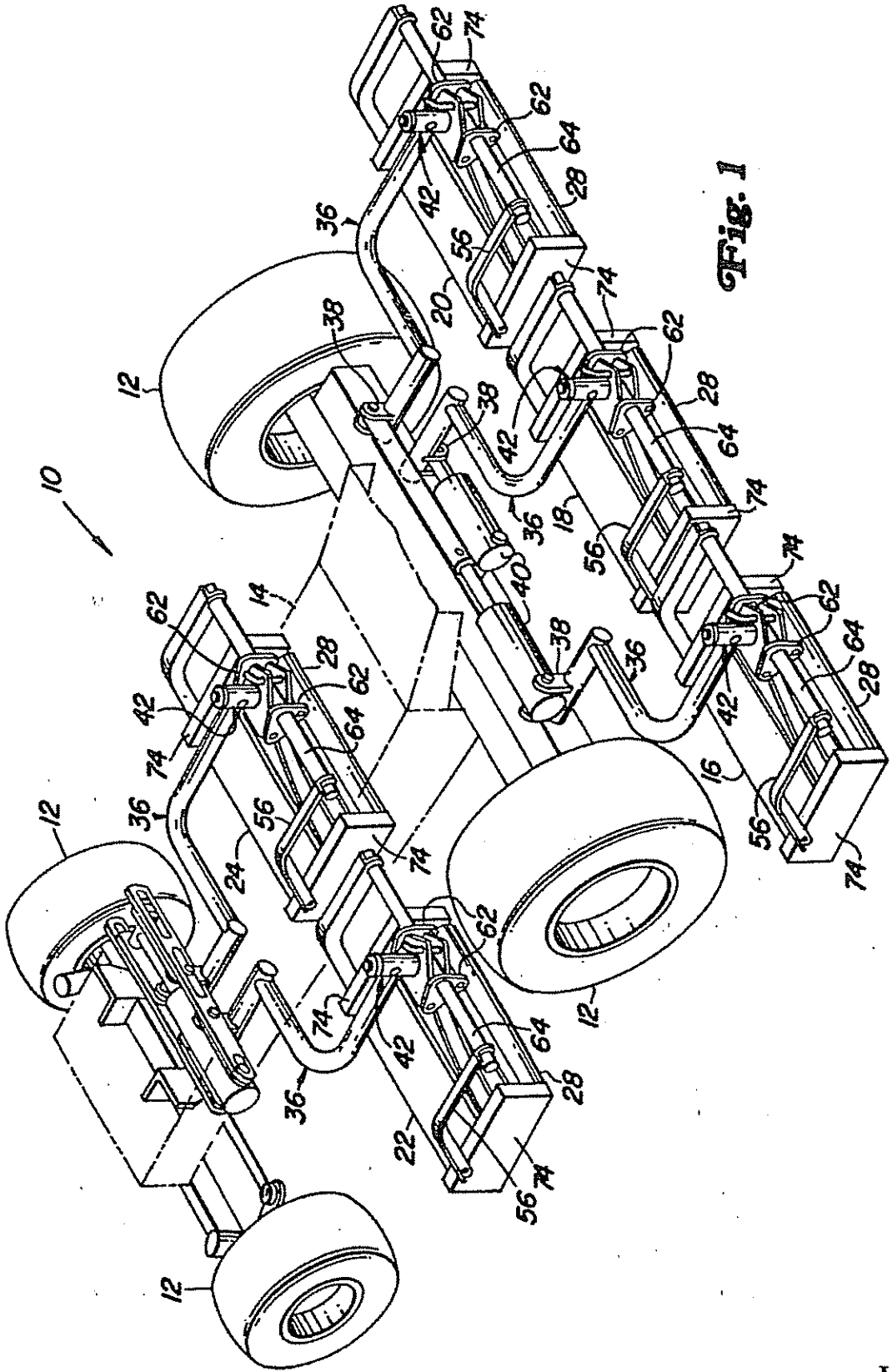


Fig. 1

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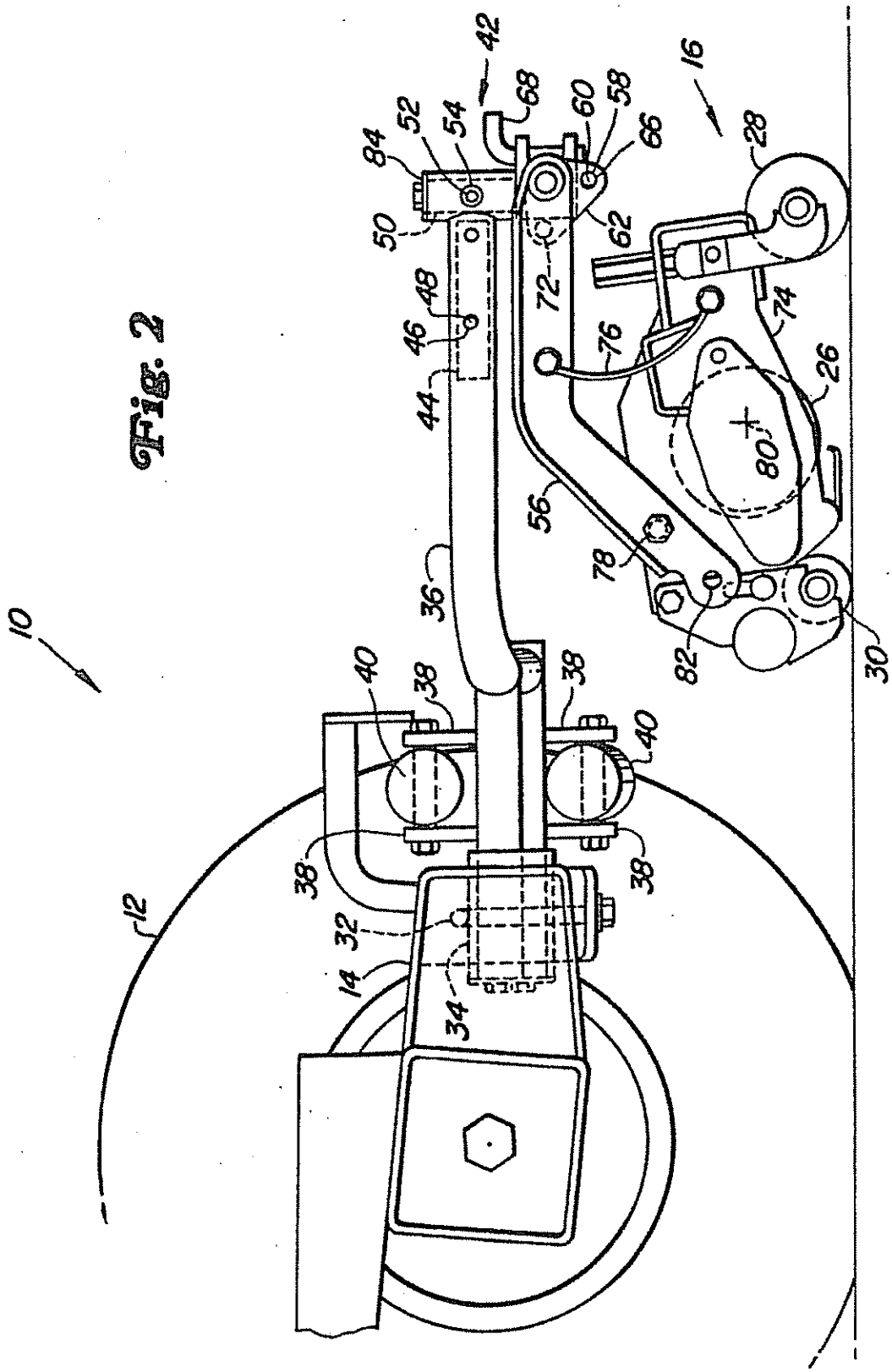
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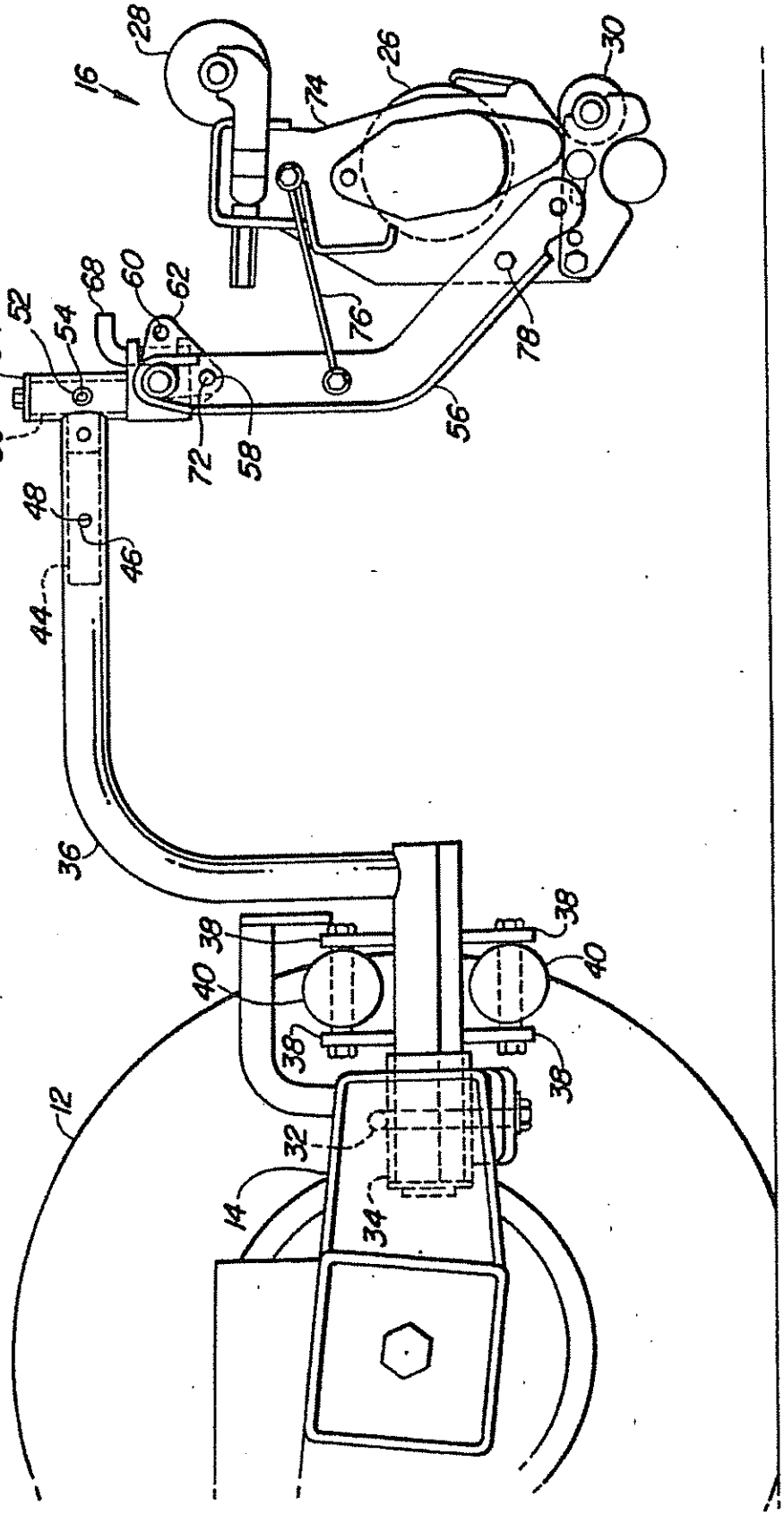
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Fig. 3

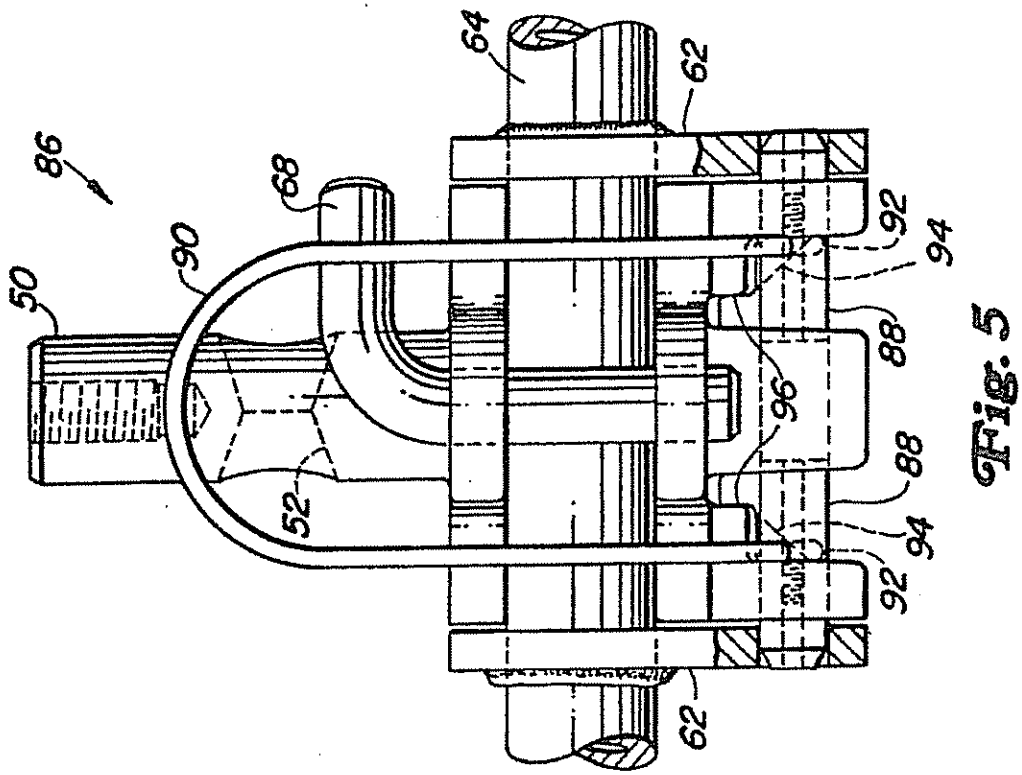
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Fig. 5

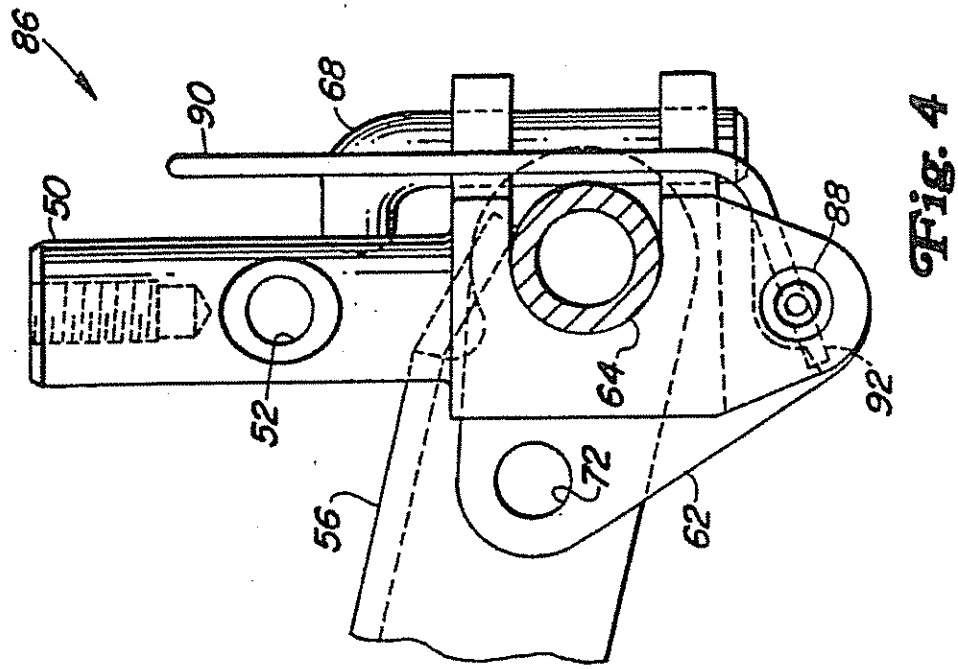
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Fig. 4

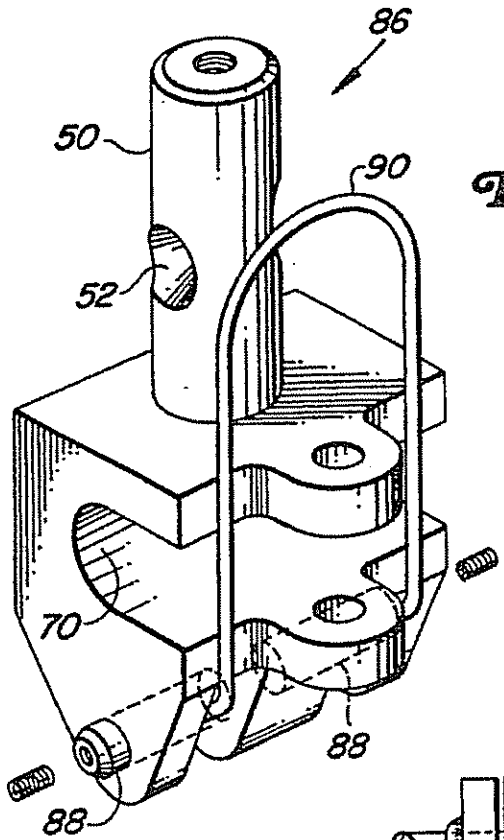

Fig. 6

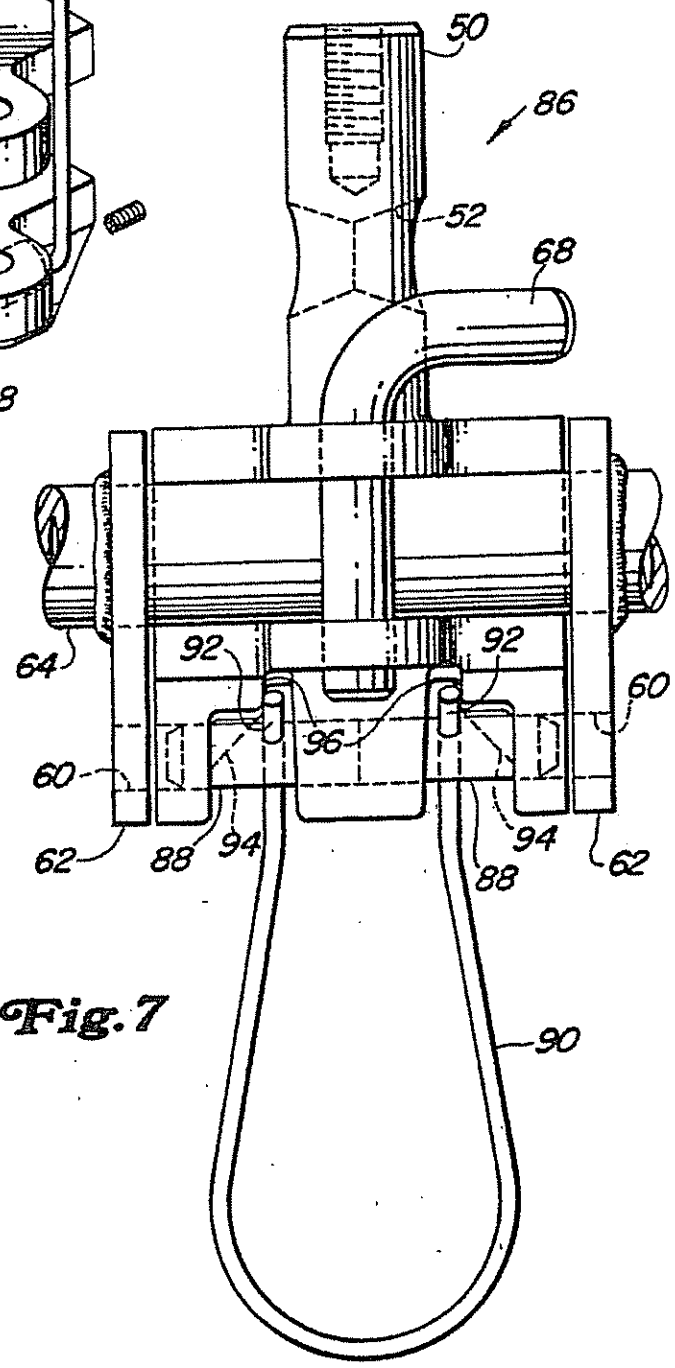

Fig. 7

Fig. 8

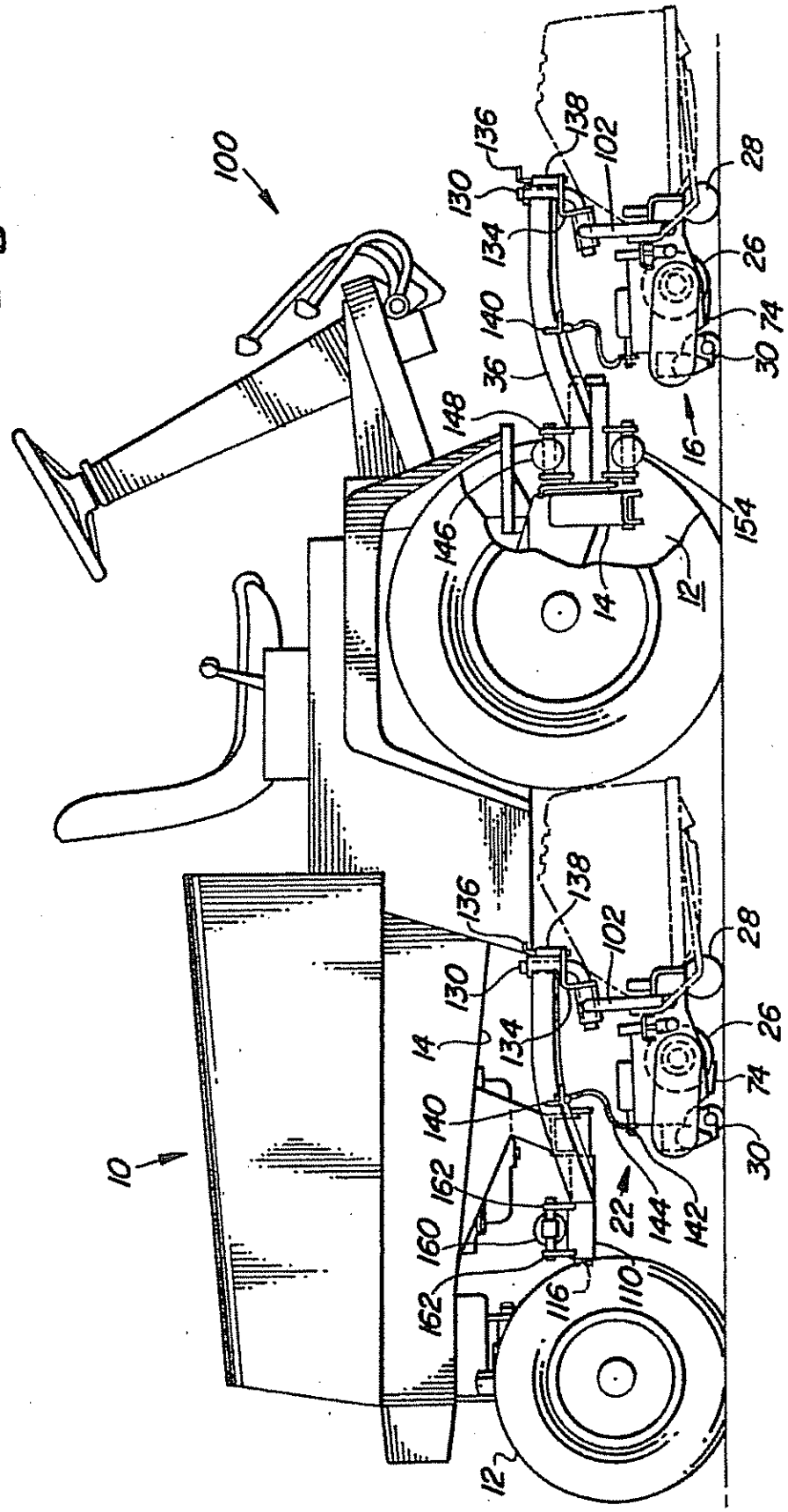
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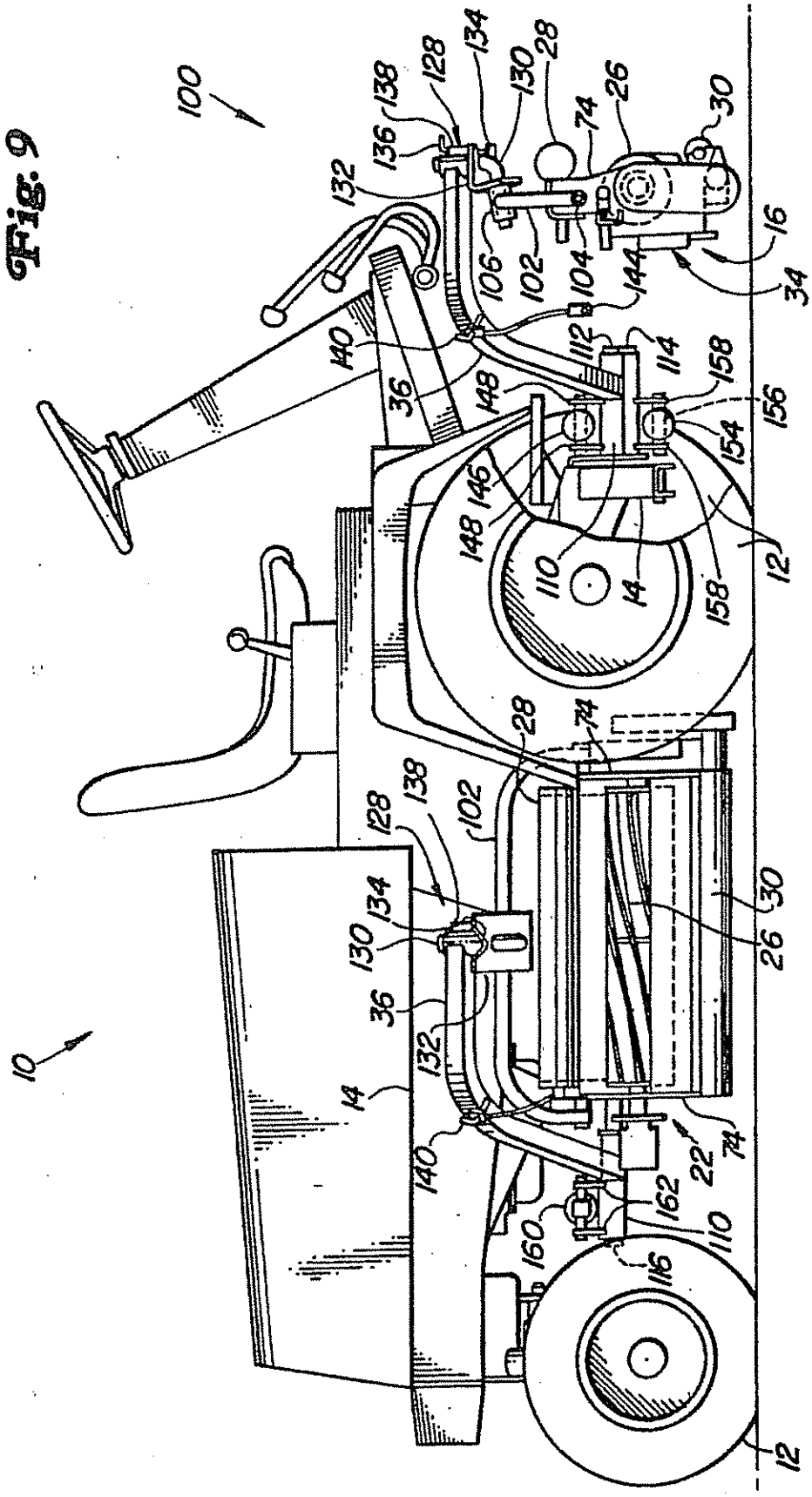
Fig. 9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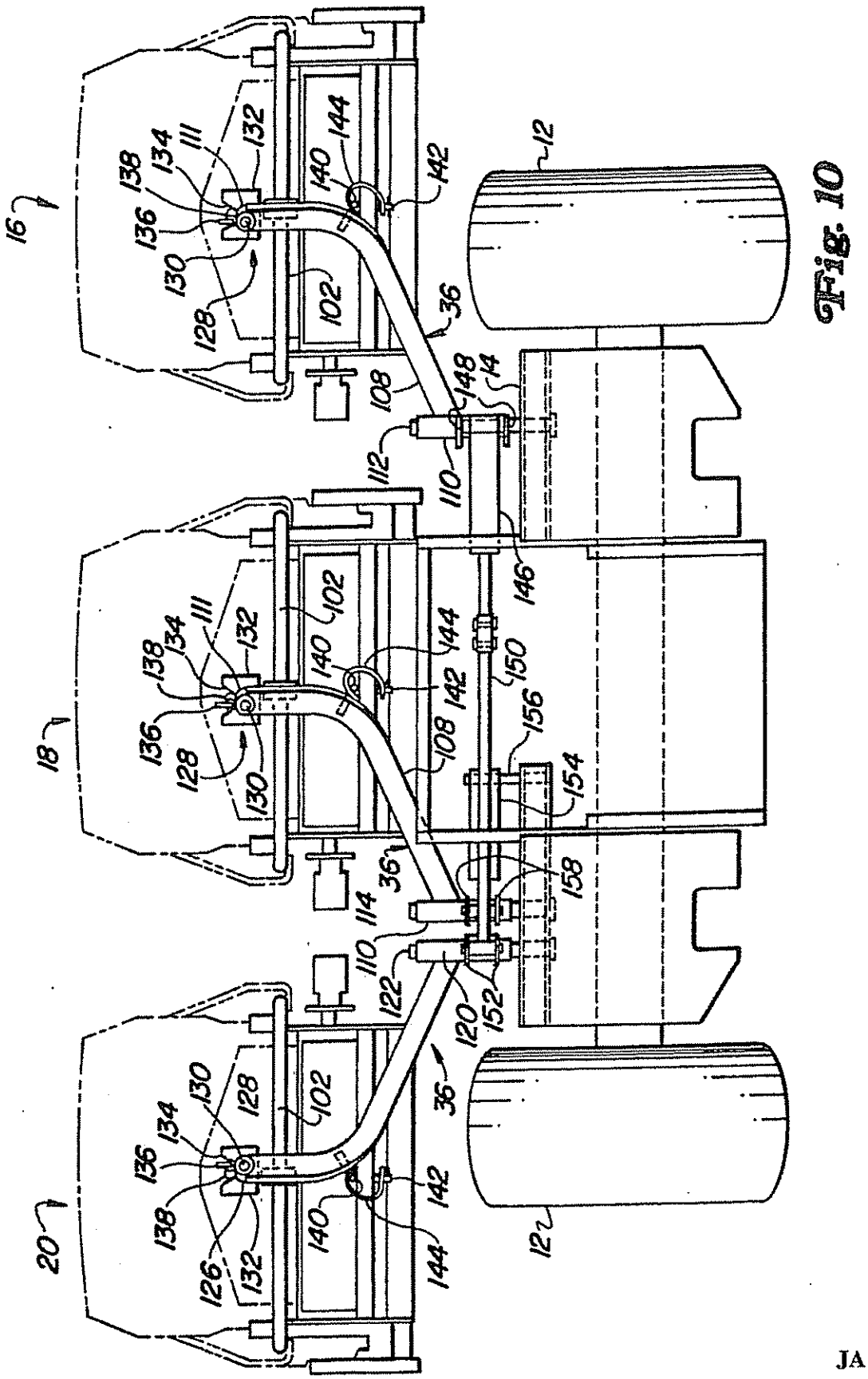
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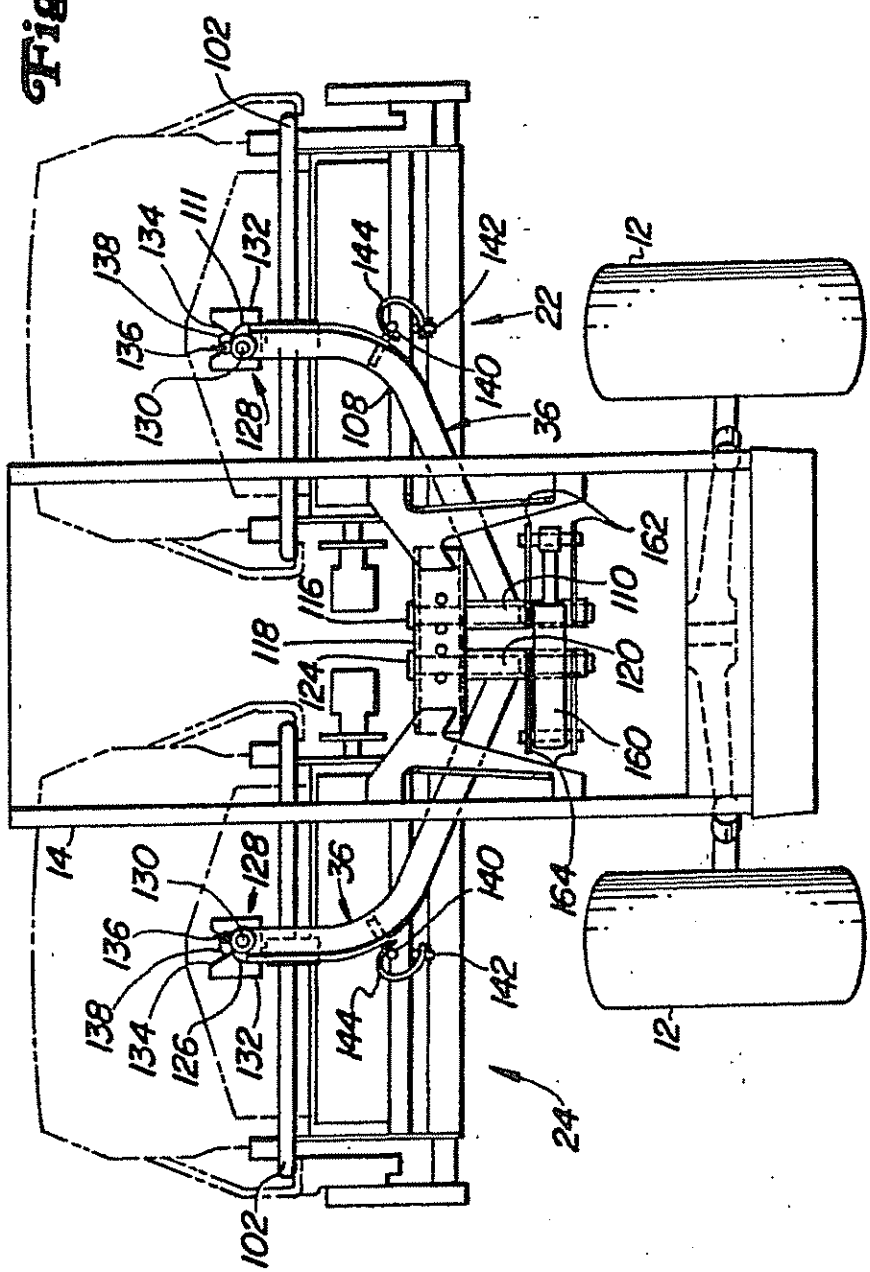
Fig. 10

Fig. 11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SUSPENSION MECHANISM FOR REEL MOWERS

BACKGROUND OF THE INVENTION

This invention relates to reel mowers and the mechanisms used to attach or suspend reel mowers from vehicles. Conventional reel mower vehicles include a plurality of arm members that extend from the vehicle, each arm having a reel-type cutting unit attached to its outer end portion. The reel-type cutting units typically include front and rear skids or rollers that support or carry the cutting units across the surface of the ground during mowing operation. Blades of the rotating reel interact with a bedknife to cut grass or other vegetation with a scissoring action.

Conventional mowing vehicles typically drag the cutting units across the ground adjacent the vehicle, and the grass beneath the cutting unit is mowed as the vehicle travels forward. A yoke is commonly coupled with the outer portion of each arm, and is also coupled to the cutting unit. The attachment point of the yoke to each cutting unit is typically located near the upper front portion of the side frames of the cutting units. The rear portions of these conventional reel mower cutting units typically experience a large degree of bouncing over irregular terrain. Also, the front rollers of these conventional mowers tends to dig down into the ground during forward travel. The front roller therefore tends to resist rising up over a bump in the ground, and will instead tend to dig down into a hill or bump. In an attempt to solve the above problems, springs have been included for biasing the rear of the cutting unit downwardly against the ground, thereby equalizing the weight carried by the front and rear rollers during forward travel and reducing the tendency of the front roller to dig or dip. These springs tend to add manufacturing and assembly costs to the vehicle. Furthermore, these springs typically must be released or otherwise detached to allow the cutting unit to be removed for service or repair, thereby complicating the removal process.

Reel mowers cut properly only if the reel to bed knife clearance is properly adjusted. Also, to produce an even cut, it is necessary that the height of cut be properly adjusted. Both of these adjustments require the person making the adjustment to access the bottom of the cutting unit. Specifically, a typical procedure for adjusting the bed knife clearance involves placing a single sheet of paper between the reel blade and bed knife and turning the reel by hand to cut the paper. The quality of the cut across the single sheet indicates whether the clearance is correct. The procedure for setting the cutting height typically involves fastening a gauge bar to the bed knife such that the upper surface of the bar is parallel to a forward, horizontal portion of the bed knife and at the desired distance below the cutting edge of the bed knife. The front and rear rollers are then adjusted to come into contact with the upper surface of the gauge bar.

Typically, the cutting units must be removed from the mower vehicle or frame in order to place the bottom of the cutting units in the line of sight of a technician for performing reel to bed knife and height of cut adjustments; or the technician must lie on his back beneath or just in front of the cutting unit when it is raised to its transport position. Obviously, neither one of these procedures is desirable, with the first consuming much valuable time and the other being quite difficult to perform.

SUMMARY OF THE INVENTION

The present invention provides a mechanism for allowing the operator to easily access the underside of the cutting units for service. A swing out feature is provided and includes a knuckle joint mechanism which allows the cutting units to swing downwardly when the lift arms are raised to a service position. The underside of the cutting units are exposed forwardly or to the side for allowing an operator to service the cutting units. The knuckle joint mechanism helps the operator easily switch the vehicle between its mowing mode and its service mode. The knuckle joint secures the cutting unit in relatively rigid position when the cutting unit is exposed for service. The present invention also includes a mechanism for hindering the cutting unit's front roller from dipping or digging into the ground during forward mowing operations, and for generally hindering the cutting unit's rear roller from bouncing up during forward travel. A particular connection point is provided at the upper rear quadrant of the cutting unit's side frame which generally balances the forces transmitted to the ground by the respective front and rear rollers for enhancing the cutting unit's ability to roll properly across the ground. Cut quality is thereby increased.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a partial perspective view of a mowing vehicle having thereattached an embodiment of the present invention which includes a rearwardly located connection point.

FIG. 2 is a side elevation view of the right front cutting unit in its ground engaging operating mode and having a rearwardly located connection point.

FIG. 3 is a side elevation view of the right front cutting unit having a rearwardly located connection point and shown in its raised maintenance position.

FIG. 4 is a partial side view of the second embodiment of the knuckle joint during normal mowing operations.

FIG. 5 is a front view of the second embodiment of the knuckle joint during normal mowing operations.

FIG. 6 is a perspective view of the second embodiment of the knuckle joint removed from the vehicle.

FIG. 7 is a partial front view of the second embodiment of the knuckle joint in the released position, showing the lever pivoted downwardly and the first pins shifted inwardly.

FIG. 8 is a side view of a vehicle having a second embodiment of the swing out mechanism according to the present invention, the yokes being coupled to generally forward locations on the cutting units, the cutting units being shown in a ground engaging position for normal mowing operation.

FIG. 9 is a side view of the vehicle shown in FIG. 8, and having the cutting units raised to service positions.

FIG. 10 is a plan view of front cutting units shown in FIG. 8 and having the cutting units lowered to their mowing positions.

FIG. 11 is a plan view of the rear cutting units shown in FIG. 8 and having the cutting units lowered to their mowing positions.